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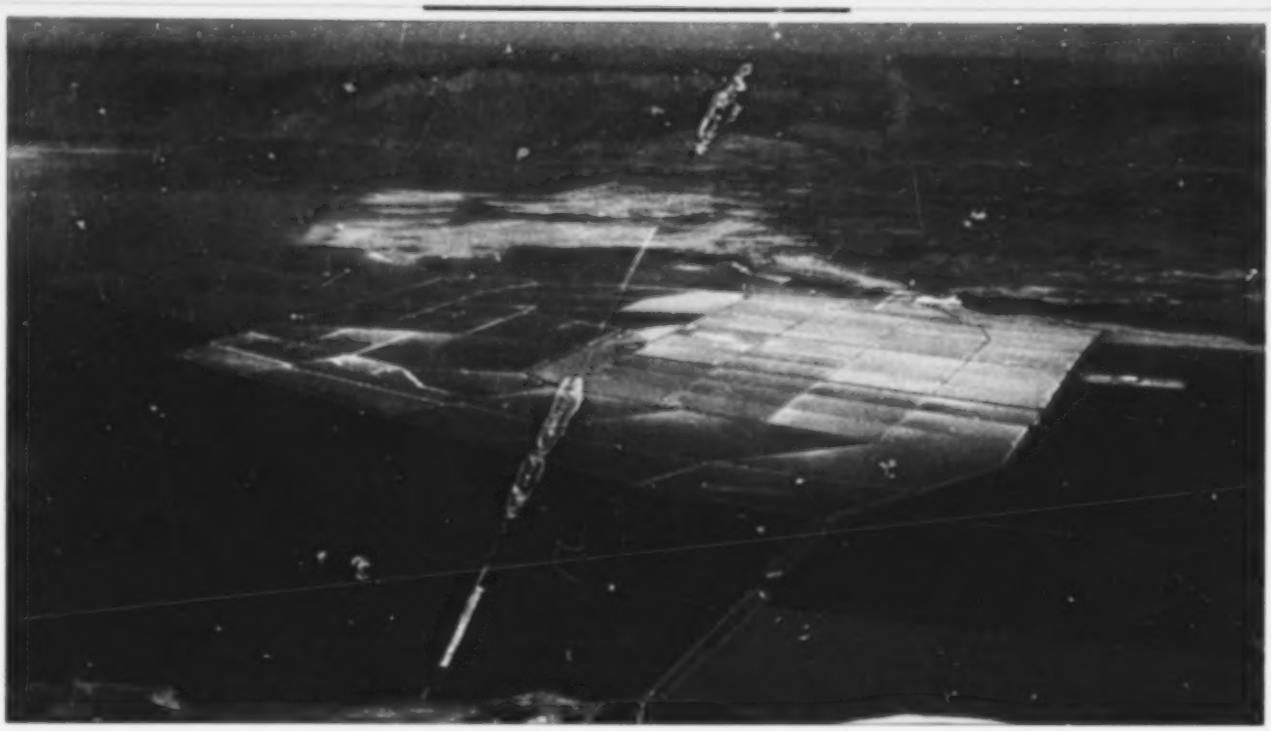

POTASH

By James P. Searls

1990

U.S. DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

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ANNUAL REPORT

POTASH

U.S.
DEPARTMENT
OF THE
INTERIOR

Manuel Lujan, Jr.
Secretary

BUREAU
OF
MINES

T S Ary
Director

September 1991

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COVER PHOTO:
The solar ponds of Great Salt Lake Minerals & Chemicals Corp. returned to production in 1989 after the outer dike was breached in 1984 by a storm.

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POTASH

By James P. Searls

Mr. Searls, a physical scientist, has been the commodity specialist for potash for 11 years. Domestic survey data were prepared by Carleen Militello, mineral data assistant; and international data were prepared by Virginia P. Woodson, international data coordinator.

U.S. potash production in terms of potassium oxide (K_2O) equivalent increased more than 7% relative to that of 1989, and apparent consumption increased 3%. The average price, f.o.b. mine, was unchanged from that of 1989 on the basis of K_2O equivalent. Yearend stocks were unchanged from those of 1989 due to parallel increases in production and sales. The New Mexico producers operated at 78% capacity by reducing their work week to help control North American product stocks.

DOMESTIC DATA COVERAGE

The U.S. Bureau of Mines developed potash domestic data from voluntary semiannual surveys of U.S. operations. Of the 12 survey requests sent to operations, 11 responded, representing 98% of total production shown in table 1.

ANNUAL REVIEW

Strategic Considerations

Strategic considerations for potash in the United States are relatively minor. Although the capacities of U.S. potash mines have not expanded to meet the expanding U.S. demand for potash, large, high-grade potash ore reserves are across the Canadian border in the Province of Saskatchewan. The United States has a long history of cooperation, friendship, and mutual investments with Canada. It, therefore, is unlikely that the United States would experience a potash cutoff by the Canadian producers. There are multiple pathways between the two countries that preclude the interdiction of trade by natural disaster or sabotage of railroad bridges or ports. The Canadian potash mine capacities were built with the expectations of sales to the U.S. market, especially the Corn Belt. A cessation of trade with the United States would close at least 60% of the Canadian capacity until the offshore markets for potash grow to replace the U.S. demand.

Production

Domestic potash production, in K_2O equivalents, increased more than 7% in 1990 over that of 1989. Producers in all four States, California, Michigan, New Mexico, and Utah, increased their production; New Mexico showed the smallest percentage increase. Of the total production for the year, 74% was standard, coarse, or granular muriate of potash, also known as potassium chloride, and 13% was sulfate of potash, also known as potassium sulfate. The remaining production included manure salts, soluble and chemical grades of muriate of potash, and sulfate of potash-magnesia, also known as potassium magnesium sulfate. The terms "standard," "coarse," and "granular" muriate of potash comprise the "three muriates," a term that ignores the soluble and chemical grades of muriate of potash. "Standard" and "soluble" grades of muriate of potash and sulfate of potash also have industrial end uses. The "sulfates" category combines the sulfate of potash-magnesia data and the sulfate of potash data. "Manure salts" formerly referred to high-grade "run-of-mine" ore; 25% K_2O potash ore is approximately 40% KCl that can be used on sugar beets. The term now refers to a mixture of white muriate of potash and common table salt for industrial uses.

The New Mexico potash producers accounted for 85% of total marketable potash salts production. Production of crude salts (ore) in New Mexico was unchanged at 14.9 million tons[1] with an average K_2O content of 13.8%. The producers were AMAX Potash Corp. of AMAX Inc., Eddy Potash Inc. of Trans-Resources Inc., IMC Fertilizers Inc. (IMCF), Mississippi Chemical Corp., New Mexico Potash Corp. of Trans-Resources Inc., and Western Ag-Minerals Co. of Rayrock Resources of Canada. All the New Mexico producers, except Western Ag-Minerals, mined sylvinite ore (the mixture of sylvite and halite from which most muriate of potash originates) and beneficiated the ore into muriate of potash. Several forms of beneficiation were used: The flotation of sylvite (potassium chloride) away from halite (sodium chloride) occurred at AMAX Potash, Eddy Potash, and Mississippi Chemical. The IMCF plant used heavy-media separation, and New Mexico Potash used selective crystallization in their plant. Western Ag-Minerals and IMCF mined langbeinite ore and beneficiated the ore to sulfate of potash-magnesia. The IMCF personnel mined both sylvinite and langbeinite ores and reacted fractions of each potash product to produce sulfate of potash.

AMAX Potash was put up for sale by its parent company near the beginning of the year. For part of the year Kali und Salz of the Federal Republic of Germany considered buying the mine through an intermediary, operating the mine to depletion, and then using the site for waste disposal. Apparently, depleted potash mines are used for waste disposal in the Federal Republic of Germany. The agreement was not signed due to funding problems. At the end of the year, a Denver, CO, gold-mining company was considering buying the mine to operate it to depletion. At the beginning of the year, a muriate of potash exporting association was established by the New Mexico producers under the auspices of the Webb-Pomerane Act. The New Mexico Potash Export Association (NewPotex)

TABLE 1

SALIENT POTASH[1] STATISTICS

(Thousand metric tons and thousand dollars, unless otherwise specified)

		1986	1987	1988	1989	1990
United States:						
Production		2,381	2,464	2,999	3,132	3,360
K_2O equivalent		1,202	1,262	1,521	1,595	1,713
Sales by producers		2,291	2,904	2,802	3,008	3,391
K_2O equivalent		1,147	1,485	1,427	1,536	1,716
Value[2]		$144,900	e$197,700	$240,300	$271,500	$303,300
Average value per ton of product	dollars	$63.24	$67.98	$85.75	$90.28	$89.46
Average value per ton of K_2O equivalent	do	$126.28	$131.73	$168.37	$176.74	$176.80
Exports[3]		1,025	926	783	945	1,016
K_2O equivalent		547	470	380	446	470
Value[4]		NA	NA	NA	NA	$136,100
Imports for consumption[3,5]		6,934	6,706	6,964	5,618	6,952
K_2O equivalent		4,212	4,073	4,217	3,410	4,164
Customs value		$385,100	$433,000	$623,000	$501,300	$545,700
Consumption, apparent[6]		8,200	8,683	8,983	7,680	8,990
K_2O equivalent		4,843	5,088	5,264	4,500	5,453
Yearend producers' stocks, K_2O equivalent		r,7 378	155	248	307	303
World: Production, marketable K_2O equivalent		r28,763	r30,459	r31,892	r29,210	e28,290

eEstimated. rRevised. NA Not available.

[1]Includes muriate and sulfate of potash, potassium magnesium sulfate, and some parent salts. Excludes other chemical compounds containing potassium.

[2]F.o.b. mine.

[3]Excludes potassium chemicals and mixed fertilizers.

[4]F.a.s. U.S. port.

[5]Includes nitrate of potash.

[6]Calculated from production plus imports minus exports plus or minus industry and Government stock changes.

[7]Inventory adjustment of minus 12,900 tons.

was created to increase sales to Latin America, but this year's sales to Latin America were disappointing, and the Association was disbanded at the end of October. At midyear, IMC Fertilizer Group Inc.'s parent company changed its name to IMCERA Group Inc. and sold off 62% of its stockholding in IMC Fertilizers Group Inc. to concentrate in animal-health products, specialty chemicals, and medical imaging media.

In Utah, Moab Salt Inc. produced muriate of potash for Texasgulf Chemical Co. from underground bedded deposits by solution mining and solar evaporation. The sylvinite salts from the solar ponds were beneficiated by flotation to separate the sylvite from the halite. Climax Chemical Co. converted some of Moab Salt's potassium chloride to potassium sulfate for sale during the first half of the year. In the first quarter of 1989, Great Salt Lake Minerals & Chemicals Corp. (GSLMC) was purchased from Gulf Resources and Chemical Corp. by a group of investors lead by D. George Harris & Associates and GSLMC management. GSLMC continued to produce sulfate of potash from the brines of the North Arm of the Great Salt Lake by solar evaporation and a proprietary process of beneficiation. GSLMC sometimes purchases muriate of potash from other sources for conversion to sulfate of potash owing to an excess of sulfate ions in the lake brine concentrate. For 1990, GSLMC imported a small amount of muriate of potash; this amount was subtracted from the import data to prevent double counting in the U.S. apparent consumption calculation. The Reilly-Wendover operation of Reilly Industries Inc. plant produced muriate of potash and manure salts by solar evaporation and flotation from near-surface brines at the west end of the Bonneville Salt Flats.

One plant in Utah manufactured sulfate of potash from muriate of potash and sulfuric acid. They reported production of about 22,000 tons K_2O equivalent for the year. The amount is not included in table 4 because the company does not mine any ore. One plant in Texas manufactured sulfate of potash in the same manner until the end of October and dismantled the plant. This production is included in table 4; the plant is operated by AMAX Potash.

In California, the muriate and sulfate of potash (and other products) operation at Searles Lake was sold by Kerr-McGee Chemical Corp. to an investment group composed of Chase Manhattan Investment Holdings Inc., Prudential Insurance Co., and Oriental Chemical Industries of Seoul, South Korea. The New York investor group D. George Harris & Associates, which previously sponsored the buyout of GSLMC, sponsored this buyout and will provide management to the new company, North American Chemical Corp. The managements of the North American Chemical Co. and GSLMC

TABLE 2

PRODUCTION, SALES, AND INVENTORY OF U.S. PRODUCED POTASH, BY TYPE AND GRADE

(Thousand metric tons and thousand dollars)

Type and grade	Production				Sold or used						Stocks, end of 6-month period			
	Gross weight		K_2O equivalent		Gross weight		K_2O equivalent		Value[e 1]		Gross weight		K_2O equivalent	
	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990
January–June:														
Muriate of potash, 60% K_2O minimum:														
Standard	342	342	209	209	387	317	236	194	30,600	25,200	118	166	72	101
Coarse	130	110	79	67	130	119	79	73	11,300	9,600	33	24	20	15
Granular	513	583	310	354	504	536	305	325	45,400	44,000	106	226	64	137
Chemical	5	9	3	5	6	8	4	5	W	W	2	2	1	1
Potassium sulfate	172	207	88	105	142	226	73	115	24,500	37,600	76	63	38	32
Other potassium salts[2]	405	445	104	119	446	508	115	134	W	W	143	147	34	34
Total[3]	1,569	1,695	793	860	1,616	1,716	812	847	r147,000	156,800	478	628	229	320
July–December:														
Muriate of potash, 60% K_2O minimum:														
Standard	371	334	227	203	348	392	212	238	26,200	28,702	142	108	86	66
Coarse	114	113	69	69	113	122	69	74	9,700	9,600	33	15	20	9
Granular	551	604	334	366	478	589	290	358	40,100	47,100	178	240	108	145
Chemical	8	5	5	3	8	7	5	4	W	W	2	(4)	1	(4)
Potassium sulfate	153	222	78	114	146	207	74	106	28,800	32,600	83	78	42	40
Other potassium salts[2]	366	387	89	98	299	358	74	88	W	W	211	176	49	43
Total[3]	1,563	1,665	802	853	1,392	1,675	724	868	124,300	146,500	649	618	307	303
Grand total[3]	3,132	3,360	1,595	1,713	3,008	3,391	1,536	1,716	271,500	303,300	XX	XX	XX	XX

[e] Estimated. [r] Revised. W Withheld to avoid disclosing company proprietary data; included in "Total." XX Not applicable.
[1] F.o.b. mine.
[2] Includes soluble muriate, manure salts, and potassium magnesium sulfate.
[3] Data may not add to totals shown because of independent rounding.
[4] Less than 1/2 unit.

are separate and distinct, but there will be some overlap in marketing.

In Michigan, Kalium Chemical Ltd. continued pilot plant development of a deep ore body and the technology to extract potash from that ore body.

Greensand, also known as glauconite, a natural silicate of potassium, aluminum, iron, and magnesium, was produced by Inversand Co., a subsidiary of Hungerford and Terry Inc., near Clayton, NJ. Production and sales information are withheld to avoid disclosing company proprietary data. Processed greensand was sold as a filter media for the removal of manganese, iron, and hydrogen sulfide from drinking water supply systems. Classified raw greensand was resold by Zook and Ranck Inc. as a soil conditioner and as a slowly released potash, with a K_2O equivalent between 5% and 10%, to the organic farmers of North America.

TABLE 3

PRODUCTION AND SALES OF POTASH IN NEW MEXICO

(Thousand metric tons and thousand dollars)

Period	Crude salts[1] (mine production)		Marketable potassium salts				
			Production		Sold or used		
	Gross weight	K_2O equivalent	Gross weight	K_2O equivalent	Gross weight	K_2O equivalent	Value[e 2]
1989:							
January–June	7,029	987	1,401	700	1,476	730	133,200
July–December	7,138	985	1,434	729	1,235	635	109,400
Total	14,167	1,972	2,835	1,429	2,711	1,365	242,600
1990:							
January–June	7,348	1,019	1,462	729	1,450	698	123,174
July–December	7,583	1,034	1,429	721	1,468	753	122,397
Total	14,931	2,053	2,891	1,450	2,918	1,451	245,571

[e] Estimated.
[1] Sylvinite and langbeinite.
[2] F.o.b. mine.

Consumption and Uses

Apparent domestic consumption of all forms of potash in 1990 increased 3% compared with that of 1989 if after correction for an error in Bureau of the Census import data. The Bureau of the Census has not issued a correction to the artificially low import figure for 1989.

The year went well for the farmers. There were no significant droughts or floods, nor were there new Government programs to restrict planting or fertilizer application. The production of grains for the year was excellent due to remarkably good weather during June, July, and August. Futures prices for grains dropped during the year.

According to the Potash & Phosphate Institute, the shipments of agricultural potash from Canadian and United States producers declined 4% from 1989 to 1990. The shipments of nonagricultural potash rose 5% for a total (agricultural plus nonagricultural) decline of 3%. The major States receiving agricultural potash from Canadian and United States producers, in decreasing order, were Illinois, Iowa, Ohio, Minnesota, Indiana, Wisconsin, and Missouri. These seven States received 56% of the total. Domestic producers accounted for 12% of the shipments to Illinois, 11% of the shipments to Iowa, 4% of the shipments to Ohio, 2% of the shipments to Minnesota, 15% of the shipments to Indiana, 2% of the shipments to Wisconsin, and 71% of the shipments to Missouri. The major receivers of domestically produced potash, in decreasing order, were Missouri, Texas, California, Illinois, Louisiana, Iowa, Indiana, Arkansas, Kansas, and Florida. These 10 States accounted for 73% of the total. The major consumers of sulfates of potash, in decreasing order, were Florida, Georgia, and California. These three States accounted for 42% of the total.

The major States for shipments of nonagricultural potash from Canadian and United States producers, in decreasing order, were Alabama, Ohio, Mississippi, and Delaware. These four States accounted for 61% of the total. In 1990, approximately 8% of total North American potash shipments were industrial (nonagricultural) potash.

Stocks

Yearend producers' stocks of potash were about 1% lower than that of 1989.

TABLE 4

SALIENT U.S. SULFATE OF POTASH[1] STATISTICS

(Thousand metric tons of K_2O equivalent and thousand dollars)

	1987	1988	1989	1990
Production	100	117	166	219
Sales by producers	109	109	147	221
Value[2]	$33,059	$36,854	$47,355	$70,226
Exports[3 4]	118	91	78	124
Value[5]	NA	NA	NA	$43
Imports[3]	26	46	r32	26
Value[6]	$10,500	$19,300	$11,700	$11,000
Consumption, apparent[4 7]	16	65	79	82
Yearend producers' stocks	16	23	42	39

r Revised. NA Not available.
[1] Excluding potassium magnesium sulfate.
[2] F.o.b. mine.
[3] Bureau of the Census.
[4] Preliminary export data pending verification by the Bureau of the Census.
[5] F.a.s. U.S. port.
[6] C.i.f. to U.S. port.
[7] Calculated from production plus imports minus exports plus or minus industry stock changes.

TABLE 5

SALES OF NORTH AMERICAN POTASH, BY STATE OF DESTINATION

(Metric tons of K_2O equivalent)

State	Agricultural potash		Nonagricultural potash	
	1989	1990	1989	1990
Alabama	57,895	75,611	111,870	140,233
Alaska	1,574	1,756	—	26
Arizona	2,807	2,920	1,749	1,297
Arkansas	57,467	49,045	103	363
California	71,063	79,540	6,839	10,376
Colorado	9,902	12,519	1,065	844
Connecticut	6,084	1,288	114	363
Delaware	16,995	23,312	39,945	42,243
Florida	154,752	127,453	749	1,214
Georgia	116,795	116,680	2,216	1,901
Hawaii	8,475	10,213	—	—
Idaho	23,787	30,273	883	2,823
Illinois	593,744	514,331	1,932	2,686
Indiana	333,268	297,302	1,630	2,895
Iowa	478,596	435,537	2,165	3,966
Kansas	46,676	44,129	1,526	2,497
Kentucky	114,280	99,660	584	619
Louisiana	131,146	180,342	3,021	2,527
Maine	3,519	6,173	549	710
Maryland	28,077	28,343	375	422
Massachusetts	2,502	4,666	679	293
Michigan	209,779	150,641	5,994	8,261
Minnesota	341,110	315,495	4,920	2,443
Mississippi	32,773	43,714	40,591	42,806
Missouri	273,227	238,467	3,270	3,035
Montana	11,492	13,075	215	191

TABLE 5—Continued

SALES OF NORTH AMERICAN POTASH, BY STATE OF DESTINATION

(Metric tons of K_2O equivalent)

State	Agricultural potash		Nonagricultural potash	
	1989	1990	1989	1990
Nebraska	32,613	33,114	1,073	1,626
Nevada	18	749	104	26
New Hampshire	780	682	24	116
New Jersey	5,270	5,576	2,500	1,126
New Mexico	9,074	5,517	21,008	15,076
New York	48,138	59,510	23,250	19,888
North Carolina	72,107	78,043	689	1,198
North Dakota	27,539	21,566	15	15
Ohio	362,297	344,509	47,116	51,174
Oklahoma	23,027	20,400	3,617	4,041
Oregon	26,454	30,627	2,181	1,500
Pennsylvania	53,886	56,747	3,101	2,851
Rhode Island	1,962	1,604	22	63
South Carolina	64,003	59,773	96	122
South Dakota	15,678	18,464	122	89
Tennessee	81,193	102,684	2,134	1,015
Texas	131,011	139,697	27,671	31,765
Utah	15,912	18,607	9,804	9,115
Vermont	3,635	5,987	—	49
Virginia	75,454	88,649	201	345
Washington	40,201	48,329	2,855	3,091
West Virginia	9,857	8,162	544	564
Wisconsin	267,447	256,432	24,345	29,018
Wyoming	2,012	3,008	21,153	851
Total	4,497,353	4,310,921	426,609	449,758

Source: Potash & Phosphate Institute.

TABLE 6

SALES OF NORTH AMERICAN MURIATE OF POTASH TO U.S. CUSTOMERS, BY GRADE

(Thousand metric tons of K_2O equivalent)

Grade	1987	1988	1989	1990
Agricultural:				
Standard	328	259	310	263
Coarse	2,078	2,095	2,036	1,882
Granular	1,866	1,530	1,658	1,658
Soluble	360	339	342	334
Total	4,632	4,223	4,346	4,137
Nonagricultural:				
Soluble	88	104	116	131
Other	269	283	305	314
Total	357	387	421	445
Grand total	4,989	4,610	4,767	4,582

Source: Potash & Phosphate Institute.

Yearend stocks represented 18% of annual production or 9 weeks of average production.

Prices

The average annual price, $176.80 f.o.b. mine, of U.S. potash sales of all types and grades, was unchanged from that of 1989. The average price was $168.64 per ton for the first half of the year and $185.18 for the second half of the year. The average annual price of the three grades of muriate was $130.13, down 5% from last year. Standard-grade muriate of potash averaged $124.75 per ton; coarse grade, $130.81; and granular grade, $133.39. The average annual price for all grades of sulfate of potash averaged $317.30 per ton.

Foreign Trade

Total potash exports as reported by the Bureau of the Census increased 5% by ton K_2O. Muriate of potash exports decreased 10%, while sulfate of potash increased 59%. The major destination for potash exports was to Latin America, which received 52%, by product tonnage. The individual countries were, in decreasing order, Brazil, Mexico, Costa Rica, Colombia, and the Dominican Republic. These five countries accounted for 72% of exports to Latin America. Three countries accounted for 75% of the non-Latin American market: in decreasing order these were Japan, China, and Canada. The U.S. Bureau of Mines determined, using prices, that the exported product in Harmonized Code category 3104.100000 was langbeinite, and these values were placed in the 3104.900000 category of sulfate of potash-magnesia.

Potash imports for consumption as reported by the Bureau of the Census increased 22% by ton product compared to that of 1989. Muriate of potash increased 19%, while sulfate of potash declined 18%. Both Eastern and Western Germany increased their exports to the United States. Canada provided 92% of all muriate of potash imports and 91% of all imports by K_2O. Israel was the second largest source of U.S. imports, with 5% of the muriate of potash imports and 6%, by K_2O content, of the total imports. The U.S. Bureau of Mines determined, using prices, that the imported product in Harmonized Code category 3104.100000 was sylvite, and these values were placed in the 3104.200000

TABLE 7

PRICES[1] OF U.S. POTASH, BY TYPE AND GRADE

(Dollars per metric ton of K_2O equivalent)

Type and grade	1988		1989		1990	
	January–June	July–December	January–June	July–December	January–June	July–December
Muriate, 60% K_2O minimum:						
Standard	119.73	122.29	129.54	123.45	129.84	120.52
Coarse	137.28	133.95	142.77	140.92	137.32	129.07
Granular	136.62	140.12	149.01	138.05	135.36	131.60
All muriate[2]	130.84	132.65	140.80	132.98	133.25	124.38
Sulfate, 50% K_2O minimum	326.98	335.76	336.48	306.96	326.34	307.47

[1] Average prices, f.o.b. mine, based on sales.
[2] Excluding soluble and chemical muriates.

TABLE 8

AVERAGE ANNUAL U.S. PRODUCER PRICE

(Dollars per metric ton, K_2O equivalent)

Year	Nominal prices						Based on constant 1990 dollars, 1982 = 100[1]					
	All types and grades	Muriate			Sulfate	Other[2]	All types and grades	Muriate			Sulfate	Other[2]
		Standard	Coarse	Granular				Standard	Coarse	Granular		
1968	30.64	23.53	27.61	29.29	—	56.18	98.91	75.96	89.13	94.55	—	181.36
1969	28.92	20.88	r24.07	25.61	—	52.37	88.43	63.85	r73.60	78.31	—	160.14
1970	39.64	29.52	35.47	r37.09	—	60.87	114.86	85.54	102.78	r107.47	—	176.38
1971	42.84	34.83	38.78	41.47	78.32	54.43	117.42	95.47	106.30	113.67	214.67	149.19
1972	44.22	36.52	38.87	39.99	89.19	56.82	115.73	95.58	101.73	104.66	233.43	148.71
1973	47.69	38.14	r41.08	42.78	91.14	71.64	117.25	93.77	r101.00	105.18	224.08	176.13
1974	r38.07	58.04	58.83	56.52	122.12	100.42	r85.80	130.80	132.59	127.38	275.22	226.32
1975	99.69	84.45	83.33	81.69	188.95	130.74	204.59	173.31	171.02	167.65	387.78	268.31
1976	92.97	69.54	73.33	76.69	219.61	137.09	179.31	134.12	141.43	147.91	423.56	264.40
1977	92.66	63.56	79.37	79.72	191.36	150.63	167.56	114.94	143.53	144.16	346.04	272.39
1978	98.17	67.97	81.81	83.66	203.68	161.83	165.47	114.57	137.90	141.02	343.32	272.78
1979	116.91	87.34	100.97	101.84	226.67	189.79	181.02	135.23	156.34	157.68	350.96	293.86
1980	159.63	r127.02	139.36	138.63	261.79	227.88	226.69	r180.38	197.90	196.86	371.76	323.61
1981	r172.04	136.55	141.61	136.86	349.23	262.78	r222.74	176.79	183.34	177.19	452.14	340.22
1982	148.87	106.36	r115.09	109.53	352.35	248.56	181.17	129.44	r140.06	133.30	428.81	302.50
1983	145.97	95.45	106.72	102.05	341.64	228.71	170.98	111.80	125.00	119.53	400.17	267.89
1984	147.53	106.33	110.22	110.79	375.45	243.84	166.71	120.16	124.55	125.19	424.26	275.54
1985	140.89	100.07	96.21	92.60	353.28	246.54	154.19	109.52	105.30	101.34	386.64	269.82
1986	r126.28	80.99	87.49	81.17	312.82	298.40	141.32	86.38	93.32	86.58	333.65	318.27
1987	r131.73	93.68	99.80	r124.09	303.43	271.73	137.65	97.03	103.37	r97.03	314.27	281.45
1988	168.37	121.05	135.69	138.28	335.74	282.25	168.37	121.05	135.69	138.28	335.74	282.25
1989	176.74	126.67	141.91	143.67	321.90	307.77	184.02	131.88	147.75	149.58	335.15	320.44
1990	176.80	124.75	130.81	133.39	317.30	296.56	176.80	124.75	130.81	133.39	317.30	296.56

r Revised.
[1] GNP Implicit Price Deflator used.
[2] Includes chemical and soluble muriates, manure salts, potassium magnesium sulfate, and before 1971, potassium sulfate.

category of muriate of potash.

World Review

World production declined 3% from that of 1989. World prices, as exemplified by the per ton price of standard muriate of potash, f.o.b. Vancouver, Canada, rose from approximately $162.50 per ton ($97.50 per short ton of product) level in October to approximately $170 per ton ($101 per short ton of product) through the end of the year. On the same basis, granular potash, which usually moves in parallel with the price of standard potash, finished the year at approximately $183 per ton ($110 per short ton of product). These prices were reported by the British Sulphur Corp. Ltd. This upward movement in price comes from a concerted effort by the Canadian (and United States) potash producers to restrict production, reduce stocks, and increase profitability.

TABLE 9

U.S. EXPORTS OF POTASH, BY TYPE

	Approximate average K_2O content (percent)	Quantity (metric tons)		Value (thousands)
		Product	K_2O equivalent	
1989:				
Potassium chloride, all grades	61	496,575	302,911	NA
Potassium sulfate	51	153,271	78,168	NA
Potassium magnesium sulfate	22	295,609	65,034	NA
Total	XX	945,455	446,113	NA
1990:				
Potassium chloride, all grades	61	445,810	271,944	$46,450
Potassium sulfate	51	243,738	124,306	43,271
Potassium magnesium sulfate	22	318,176	69,998	41,399
Potassium nitrate	45	7,841	3,528	4,998
Total	XX	1,015,565	469,776	136,118

NA Not available. XX Not applicable.

Source: Bureau of the Census.

Brazil.—There are reports that the Tarquari-Vassouras Mine was closed during the year due to the newly elected Government's refusal to further subsidize production.

Canada.—Saskatchewan producers, other than Potash Corp. of Saskatchewan (PCS), operated at an average 80% capacity factor, while PCS operated at an average 40% capacity factor, to keep North American stock levels below 2 million tons. The average capacity factor for the Province was 60%. The proposed sale of the Saskterra Fertilizers Ltd. 40% share of the Allan Mine to the Dead Sea Works was halted due to financial disagreements. This share of the mine was eventually sold to PCS, the operator, who owned the other 60% of the mine. Groupe Entreprise Minière et Chimique (EMC) of France purchased Canamax Resource Inc.'s 51% share in the proposed Russell-Binscarth Mine, which is east of Esterhazy and a few miles across the Provincial border into Manitoba. The remaining 49% of the property is owned by the Provincial Government of Manitoba. It would operate in the rich Esterhazy member of the Elk Point Basin if put into production. With Saskatchewan potash producers operating at only 60% of capacity, an immediate need for new potash capacity does not seem to exist. At midyear, Denison Mines Ltd. put its 60% ownership of Denison-Potacan Potash Co. on the market to reduce long-term indebtedness. The leak in the International Minerals & Chemicals (Canada) Ltd.'s Esterhazy K-2 Mine, which began in 1986, has been throttled but not stopped. The company has started to consider sinking another shaft into an unconnected portion of its reserves to start a new mine and maintain operations.

Chile.—AMAX Inc. was reported to be withdrawing from the Minsal Project in the Salar de Atacama.[2] The Yolanda Project, to be operated by the North Lily Mining Co.[3] of California, United States, will mine sodium nitrate and iodine, converting the sodium nitrate to potassium nitrate using imported muriate of potash. It is not clear how far the price of potassium nitrate would fall if more material from new production capacity was to be introduced into the world market.

China.—China has raised its estimate of the reserves at the Qaidam Basin salt flats from 200 million tons to 222 million tons and considers that basin to contain 70% of the country's total of 320 million tons.[4]

European Commission.—The European Commission opened antidumping investigations following the filing by the European Potash Producers Association of dumping charges against the U.S.S.R.

France.—Groupe Entreprise Minière et Chimique (EMC) became involved in the French chemical reorganization when it was considered for merger, which was later dropped, with Société Nationale Elf Aquitaine under Entreprise de Recherche et d'Activité Pétrolières (ERAP). Another state owned chemical company, Orkem, has been split into two parts with its fertilizer divisions going to EMC and its chemical divisions going to Elf Aquitaine's Atochem in 1995. Entreprise Minière et Chimique's Alsatian Mines will run out of minable ore in the year 2004 (exactly 100 years since discovery). Entreprise Minière et Chimique will have its 50% portion of the New Brunswick, Canada, mine and potentials in both Manitoba, Canada, and the People's Republic of the Congo. Entreprise Minière et Chimique is determined to stay in the fertilizer business even though they will no longer be mining potash in France. However, for the Alsatian Mines, the company started to consider storing hazardous (nonliquid, nonflammable, nonradioactive) waste as a possible use of the depleted mines and as a source of employment for the Mulhouse region.

TABLE 10

U.S. EXPORTS OF POTASH, BY COUNTRY[1]

(Metric tons of product)

Country	Potassium chloride		Potassium sulfates, all grades[2]		Potassium nitrate		Total[3]	
	1989	1990	1989	1990	1989	1990	1989	1990
Algeria	1,200	—	—	—	—	—	1,200	—
Argentina	7,200	10,370	1	5,230	—	—	7,200	15,600
Australia	830	20	9,280	6,960	—	—	10,110	6,980
Bahamas	—	—	640	80	—	—	640	80
Bangladesh	—	—	—	2,200	—	—	—	2,200
Belize	2,790	2,580	430	190	—	—	3,220	2,770
Bolivia	530	290	580	18	—	19	1,110	327
Brazil	229,820	162,320	21,470	4,000	—	—	251,290	166,320
Canada	1,710	6,300	54,310	87,200	—	4,660	56,020	98,160
Chile	6,800	12,980	20,270	18,120	—	—	27,070	31,100
China	—	—	73,940	105,670	—	—	73,940	105,670
Colombia	53,870	38,160	25,020	15,460	—	—	78,890	53,620
Costa Rica	26,550	31,730	23,110	22,310	—	—	49,660	54,040
Dominican Republic	35,820	45,570	3,930	3,160	—	—	39,750	48,730
Ecuador	6,130	17,350	13,020	13,380	—	10	19,150	30,740
Egypt	130	—	—	1,000	—	—	130	1,000
El Salvador	4,080	1,080	500	1,000	—	—	4,580	2,080
Fiji	—	—	—	2,090	—	—	—	2,090
France	7	—	—	—	—	—	7	—
Greece	—	—	—	1	—	—	—	1
Guatemala	5,200	—	3,700	4,400	—	—	8,900	4,400
Guyana	—	500	400	—	—	—	400	500
Honduras	1,900	9,690	6,990	90	—	—	8,890	9,780
Hong Kong	—	—	—	400	—	—	—	400
India	—	—	—	18,400	—	—	—	18,400
Indonesia	—	—	—	7,970	—	—	—	7,970
Italy	800	14,850	—	16,550	—	—	800	31,400
Japan	16,520	19,140	116,300	135,060	—	3,060	132,820	157,260
Korea, Republic of	11,430	—	80	6	—	3	11,510	9
Malaysia	—	—	—	14,700	—	—	—	14,700
Martinique	—	8,820	—	4,550	—	—		13,370
Mexico	61,330	26,960	37,140	34,600	—	78	98,470	61,638
New Zealand	120	—	460	250	—	—	580	250
Pakistan	—	—	—	29,570	—	—		29,570
Panama	2,140	7,250	860	1,870	—	—	3,000	9,120
Peru	12,140	2,000	21,070	—	—	—	33,210	2,000
Philippines	9	3	—	37	—	1	9	41
Saudi Arabia	—	—	—	1	—	—	—	1
Sweden	950	950	—	—	—	—	950	950
Taiwan	—	—	350	37	—	—	350	37
Thailand	—	—	4,000	5,300	—	3	4,000	5,303
Trinidad	2,610	2,540	490	35	—	—	3,100	2,575
United Kingdom	3,530	340	2	—	—	—	3,532	340
Uruguay	—	2,801	—	—	—	—	—	2,801
Venezuela	42	20,950	10,500	—	—	2	10,542	20,952
Other	390	266	36	19	—	4	426	289
Total[3]	496,575	445,810	448,880	561,914	—	7,840	945,455	1,015,565

[1] The Bureau of the Census ceased publication of value data in 1985, but now makes value by code, by month available.

[2] Includes potassium magnesium sulfate.

[3] Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census.

TABLE 11

U.S. IMPORTS FOR CONSUMPTION OF POTASH, BY COUNTRY

Country	Metric tons of product										Total value (thousands)			
	Potassium chloride		Potassium sulfate		Potassium nitrate		Potassium sodium nitrate		Total[1]		Customs		C.i.f.	
	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990	1989	1990
Belgium-Luxembourg	21	2,500	5,800	11,900	—	139	—	—	5,800	14,500	$1,100	$2,400	$1,200	$3,000
Canada	5,089,800	6,286,500	900	500	—	5	—	18,300	5,090,700	6,305,300	440,100	481,900	509,200	601,300
Chile	—	—	—	—	19,000	13,800	11,500	29,300	30,500	43,100	5,100	6,200	6,000	7,300
France	—	—	10,200	4,000	—	—	—	—	10,200	4,000	1,800	700	2,200	800
Germany, Federal Republic of:														
Western states	400	18,800	45,600	35,400	—	—	—	—	46,000	54,200	7,200	8,000	8,100	9,100
Eastern states	56,300	122,900	—	—	—	24	—	—	56,300	122,900	5,000	8,100	5,700	9,200
Israel	248,200	363,300	—	—	14,700	22,000	—	—	262,900	385,300	30,400	36,500	34,300	40,000
Italy	—	—	400	5	—	—	—	—	400	5	40	2	40	3
Japan	40	—	—	73	6	7	100	200	150	280	90	180	100	200
Jordan	22,000	—	—	—	—	—	—	—	22,000	—	2,000	—	2,400	—
Mexico	—	—	—	—	—	1	—	—	—	1	—	1	—	1
Netherlands	3,000	—	73	—	—	—	—	—	3,100	—	343	—	400	—
Poland	—	—	—	—	36	80	—	—	36	80	20	30	20	40
U.S.S.R.	87,200	21,800	—	—	—	—	—	—	87,200	21,800	7,900	1,500	9,600	1,800
United Kingdom	3,000	223	—	—	—	20	—	—	3,000	243	180	173	220	204
Yugoslavia	—	—	—	—	—	23	—	—	—	23	—	20	—	20
Total[1]	5,510,000	6,816,000	63,000	51,900	33,700	36,100	11,600	47,800	5,618,300	6,951,700	501,300	545,700	579,500	673,000

[1] Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census, as adjusted by the U.S. Bureau of Mines.

Germany, Federal Republic of.— Early in the year Kali und Salz closed two mines, Hattorf and Wintershall, for a short period to maintain stocks at reasonable levels. As the reunification with East Germany approached, the concern was about reducing the salt pollution in the Werra River by replacing East German production with West German production and modifying East German technology in other plants. It was felt that 16 million tons of salt per year could be withheld from the Werra and Weser Rivers.

With the simultaneous dissolution of the centrally planned economic operation and combination with the Federal Republic of Germany in the middle of the year, VEB Kalikombinat founded Mitteldeutsche Kali AG and three potash mining companies, Zielitz Kali AG (Zielitz), Kali Werra AG (Ernst Thälman or Merkers, Wilhelm Pieck, Marx-Engels), and Kali Südharz AG (Glückauf or Sondershausen, Volkenroda or Menteroda, Karl Marx or Sollstedt, Heinrich Rau or Rossleben). Volkenroda was

TABLE 12

U.S. IMPORTS FOR CONSUMPTION OF POTASH, BY TYPE

	Approximate average K_2O content (percent)	Quantity (metric tons)		Value (thousands)	
		Product	K_2O equivalent[e]	Customs	C.i.f.
1989:					
Potassium chloride	61	5,510,000	3,361,000	$481,200	$556,200
Potassium sulfate	51	63,000	32,100	10,200	11,700
Potassium nitrate	45	33,700	15,200	8,600	10,000
Potassium sodium nitrate mixtures	14	11,600	1,600	1,300	1,600
Total	XX	5,618,300	3,409,900	501,300	579,500
1990:					
Potassium chloride	61	6,816,000	4,114,600	520,600	644,200
Potassium sulfate	51	51,900	26,400	9,500	11,000
Potassium nitrate	45	36,100	16,200	10,100	11,400
Potassium sodium nitrate mixtures	14	47,800	6,700	5,500	6,300
Total	XX	[1]6,951,700	4,163,900	545,700	[1]673,000

[e] Estimated. XX Not applicable.

[1] Data do not add to total shown because of independent rounding.

Source: Bureau of the Census, as adjusted by the U.S. Bureau of Mines.

closed during 1990. Earlier in the year a conveyer belt was completed between the Wilhelm Pieck Mine and the Ernst Thälman Mine to circumvent the damage of the 1989 collapse in the Ernst Thälman Mine and keep the production at that mine at four-fifths of previous production. Kali Bergbau/Handelsgesellschaft mbH continues to handle sales to long-standing contracts and former Comecon countries. Some potash will be handled through Kali Export Gesellschaft.

Israel.—The concept of privatization was withering on the vine as several Government officials expressed reservations concerning extra-Israel control over the second most important Israeli source of exports. By the end of the year, the differences in valuation of the 50% share of the company, which would not be controlling in major decisions, put the sale beyond expectations. The tensions in the Gulf of Arabia had little effect on shipments and no effect on production for the year.

Italy.—A drought in Sicily halted Italkali SpA's production of sulfate of potash between July and end of the year due to lack of water for the beneficiation plant.

Japan.—The Co-op Chemical Co. Ltd. commenced construction of its sulfate of potash plant in Niigata-Higasiko. Plant capacity has been put at 10,000 tons per year using imported muriate of potash.

Jordan.—The tensions in the Persian Gulf region had no effect on production and little effect on shipments of potash. The Arab Potash Co. decided to increase its capacity from 1.4 million to 1.8 million tons per year using either the cold-crystallization technology or flotation technology. The new capacity, probably cold-crystallization, is expected to be on-line in 1994.

Korea, North.—The Sariwon Potassic Fertilizer Complex tested its kiln for the first time this year. It is questionable that the energy required to separate potassic feldspar into sulfate of potash, alumina, and cement aggregate will allow a profitable operation considering the world price of potash.

Poland.—Poland reports that it produced 137,000 tons of potassic fertilizer in 1990. Because there is now nitrate of potash being imported into the United States from Poland, this production would appear to be nitrate of potash manufactured from muriate of potash. This muriate of potash could be purchased from either the U.S.S.R. or the Federal Republic of Germany and combined with indigenous nitrogen fixation product.

Spain.—The fertilizer components of Explosivos Rio Tinto, S.A. (ERT) and S.A. Cros combined in 1988 to form Fertilizantes Espanoles, S.A. (FESA). The remaining segments of ERT and S.A. Cros merged to form ERCROS, S.A., which purchased 80% of Empresa Nacional de Fertilizantes, S.A., (Enfersa) in 1989. Kuwait Investment Office (KIO) purchased 51% of ERCROS in 1988. In 1990, FESA, now controlled by ERCROS, merged with Enfersa. In 1990, ERCROS, through FESA, shut down the

TABLE 13

WORLD POTASH ANNUAL PRODUCTION CAPACITY, DECEMBER 31, 1990, RATED CAPACITY[1]

(Thousand metric tons of K_2O equivalent)

North America:	
Canada	11,520
Mexico	NA
United States	1,920
Total	13,440
South America:	
Brazil	150
Chile	45
Total	195
Europe:	
France	1,680
Germany, Federal Republic of:	
Western states	2,700
Eastern states	2,900
Italy	400
Spain	750
U.S.S.R.	13,700
United Kingdom	490
Total	22,620
Asia:	
China	120
Israel	1,350
Total	1,470
World total[2]	37,725

NA Not available.
[1]Includes capacity at operating plants as well as at plants on standby basis.
[2]Data do not add to total shown because of independent rounding.

TABLE 14

WORLD POTASH RESERVES AND RESERVE BASE

(Million metric tons, K_2O equivalent)

	Reserves	Reserve base[1,2]
North America:		
Canada	4,400	9,700
Mexico	NA	NA
United States	85	360
Total[3]	4,500	10,000
South America:		
Brazil	50	400
Chile	10	50
Total	60	450
Europe:		
France[2]	16	45
Germany, Federal Republic of:		600
Western states	500	—
Eastern states	300	—
Italy[2]	20	40
Spain[2]	30	50
U.S.S.R.[4]	3,600	22,600
United Kingdom[2]	25	30
Total[3]	4,500	24,400
Africa:		
Congo	—	20
Ethiopia	NA	NA
Tunisia	NA	NA
Total	—	20
Asia:		
China	320	NA
Israel	54	150
Jordan	54	150
Laos	NA	20
Thailand	NA	100
Total[3]	400	400
World total[3]	9,500	35,300

NA Not available.
[1]The reserve base includes demonstrated resources that are currently economic (reserves), marginally economic (marginal reserves), and some of those that are currently subeconomic (subeconomic resources).
[2]Based on recent studies by U.S. Bureau of Mines, Division of Minerals Availability.
[3]Data may not add to totals shown because of independent rounding.
[4]The U.S.S.R. has increased the reserve base of the Upper Kama Basin to 19 billion tons. Apparently, the carnallite ores can be mined.

TABLE 15

SALIENT CANADIAN POTASH STATISTICS

(Thousand metric tons of K_2O equivalent)

	1987	1988	1989	1990
Production[1]	7,267	8,327	7,360	7,002
Domestic sales by domestic producers[1]	499	416	315	393
Exports:				
United States[1]	4,223	4,248	3,886	3,630
Overseas[1]	3,133	3,792	2,924	3,164
Imports for consumption[2]	19	11	16	31
Domestic consumption[3]	518	427	331	424
Yearend producers' stocks[1]	1,135	1,356	1,596	1,272

[1] Data supplied by the Potash & Phosphate Institute.
[2] From Bureau of the Census export data. Sulfate of potash and nitrate of potash were landed on the Canadian east coast from European sources.
[3] Domestic sales by domestic producers plus imports.

TABLE 16

MARKETABLE POTASH: WORLD PRODUCTION, BY COUNTRY[1]

(Thousand metric tons of K_2O equivalent)

Country	1986	1987	1988	1989	1990[e]
Brazil	r11	r37	r54	r97	60
Canada[2]	6,753	7,668	r8,154	r7,074	r7,372
Chile[4]	20	23	25	e25	25
China[e]	40	40	40	40	40
France	1,617	1,539	1,502	r1,195	1,300
Germany, Federal Republic of:					
Western states	2,161	2,199	r2,290	r2,182	2,200
Eastern states	3,485	3,510	3,510	3,200	2,700
Israel	1,255	1,253	1,244	r1,338	1,350
Italy	r119	r134	r148	r156	60
Jordan	660	734	785	r793	790
Spain	795	741	r855	r850	r690
U.S.S.R.	10,228	10,888	11,301	r10,200	9,500
United Kingdom	r417	r431	r463	465	490
United States	1,202	1,262	1,521	1,595	r1,713
Total	r28,763	r30,459	r31,892	r29,210	29,290

[e] Estimated. [r] Revised.
[1] Table includes data available through Apr. 19, 1991.
[2] Official Government figures. Potash & Phosphate Institute production data are given in table 15.
[3] Reported figure.
[4] Data represent officially reported output of potassium nitrate product (gross weight basis) converted assuming 14% K_2O equivalent.

Cardona Mine because of ore depletion. The nearby Vittoria deposit will not be opened due to geologic problems even though the ore grade runs as high as 24% K_2O. ERCROS' Sallent Mine will be expanded from 270,000 to 350,000 tons per year K_2O.

Thailand.—The six member countries of the Association of Southeast Asian Nations (ASEAN) approved a potash mine and mill as a joint Industrial Project in Thailand. This is the Bamnet Narong Project of the early 1980's, where an incline to the 180-meter-deep ore zone was flooded in 1984.

U.S.S.R.—Free market entrepreneurship has emerged from the U.S.S.R. with "perestroika potash." This refers to potash that is sold by other than Soyuzpromexport, such as various enterprises that were allocated potash for upgrading to complete fertilizers. These enterprises are allowed to sell the potash on the world market rather than use the product internally. The potash mines in the U.S.S.R. are reported to be shifting to profit orientation. To become competitive in the world market, they will need hard currency to upgrade to equipment from hard currency countries, which can only be achieved by selling potash to the hard currency countries. The other side of the coin is that potash consumption in the U.S.S.R. is declining as the farmers have to pay unsubsidized prices for their seed, machinery, fuel, and fertilizers. The farmers may decide to delay fertilizer application until they have money from selling their crops at free market prices. Even then they may choose to invest in machinery instead of fertilizer.

A paper, published in the proceedings of the Ninth Industrial Minerals International Congress (1990) in Sydney, Australia,[5] by B. Y. Golovkov, reported that the U.S.S.R. contains 22,600 million tons of K_2O of geological reserves of minable deposits. Eighty-four percent of this is in the Upper Kama (Ural mountain) deposits or 19 billion tons of K_2O. Much of this must be carnallite.

OUTLOOK

Demand for Potash

It is interesting to read that writers are forecasting fertilizer demand growth because of the momentum of population growth around the world. One writer pointed out a world population gain forecast of 1 billion humans, the equivalent of four U.S. populations, is going to be added in the next 10 years; therefore, the world will need more potash. It is not necessarily so. Food, and the fertilizer to grow the food, have to be paid for. The transportation of the foodstuffs from the fields to the new humans has to be paid for. Many of the families with these 1 billion new children will not be able to pay for more food. The growth of potash consumption requires that there is additional money to pay for both the potash and the required transportation costs. Analysis of the consumption patterns of several of the economic regions of the world tend to demonstrate that in some parts of the world, private consumption

tends to crowd out the consumption of potash. An example of this might be energy imports.

For 1987, the average calories per day consumed in the developed countries of the world is 3,345 calories. The average population growth rate for these countries is 0.6% per year. Their average gross national product (GNP) per capita in U.S. dollars is $11,350 per capita. The average daily caloric intake for Latin America is 2,560 calories. Its population growth rate is 2% per year. Its average GNP per capita in U.S. dollars is $1,910 per capita. The average daily caloric intake for the Sub-Saharan portion of Africa is 2,225 calories, some of which is likely gathered from indigenous plants. Its population growth rate is 3% per year. Its average GNP per capita in U.S. dollars is $640 per capita (with a median of $335). Not all countries can achieve or even strive to feed their people in the near future at the same level of caloric intake as the developed countries. It is not predetermined that they will do so in the future. Of course, not all countries have the governmental policies in place to have a large effect on the average daily caloric intake of its population. Further, it seems clear that large population growth, at present, is joined to a low average daily caloric intake. Generally, population growth indicators such as "crude birth rate" and "total fertility rate" showed neither positive nor negative significance.

An assortment of macroeconomic and other variables published by the World Bank for a single year (1987) were investigated that might describe the financial health, investment attitudes, and a few sociological indicators for many of the countries for their predictive relationship to potash consumption. The world was divided into economic groups following the lead of the World Bank: the Developed Countries, the Sub-Saharan African Developing Countries, Latin America and Caribbean, Asian, etc. Parallel to this data, the United Nations Food and Agricultural Organization (FAO) provides potash consumption by country and by kilograms per hectare of (a) agricultural land, (b) arable land and permanent crops, and (c) per capita for approximately all countries of the world.

The Developed Countries.—The developed countries respond to a pair of factors and to one of these in a surprising manner. The economic system of the developed countries makes a clear calculation of the food demand per person, the food producible per area, and the potash needed to grow that amount of food per area. For the developed countries, the two variables were "arable hectares per capita," which would describe the amount of land available for grains, vegetables, oils, and fibers, and "agricultural hectares per capita," which would includes arable hectares plus the hectares for tree crops and grazing lands. These countries have a high enough GNP per capita to fertilize their grazing lands and tree crops. Curiously, the "agricultural hectares per capita" is negatively correlated to the total potash per hectare. The R^2 of this regression is 0.838, which means that the two variables explain about 90% (the approximate square root of 0.838) of the variation within the countries in the grouping. For predictive purposes, the excess production of food (for exports and stocks) in both North America and Western Europe, the declining potash consumption in the United States (since 1980), plus the slow or zero growth in potash consumption in Western Europe would indicate zero or declining potash consumption growth in this group of countries. The average population growth rate for the developed countries was 0.5% per year between 1980 and 1988. The average daily caloric intake for the developed countries is 3,345 calories. This grouping of countries consumed about 44% of the world's total potash production for 1990.

For the reader's information, Andorra, Faeroe Islands, Gibraltar, Vatican City, Liechtenstein, Malta, Monaco, and San Marino were not used in the analysis. Israel, Japan, and the Republic of South Africa were in the grouping.

Latin America and Caribbean.—Latin America responds to four of the variables that were tested by regression. They responded positively only to "gross domestic investment: contribution to gross domestic product" in percentage. This could mean that countries that are making investments for growth are also sophisticated enough to make investments in potash.

This region responded negatively to the ratio of "arable hectares per capita." The countries with large arable hectares per capita apparently do not fertilize the soil as much as the countries with fewer hectares per capita. It must be that the large countries are still cropping the natural fertility of the land, while the small countries and islands must fertilize. This region also responds negatively to "private consumption: contribution to gross domestic product." This may mean that private consumption crowds out some of the investment, including fertilizers. Finally, this region responds negatively to the "crude birth rate," which is simply the number of births per year divided by the total population. This is certainly counterindicative of potash growth because of population growth. The R^2 was 0.386, meaning that the four variables explained only about 60% of the variation. The average daily caloric intake per capita was 2,563 calories. The average population growth was about 2% per year. This region received about 8% of the world's potash production for 1990.

The African Sub-Saharan.—The World Bank divided Africa into two groups, the Sub-Saharan, which was grouped together, and the Mediterranean Africa, which was grouped with the Near East. Both "K_2Oarable" (kilograms of K_2O per arable hectare) and "K_2Oagric" (kilograms of K_2O per agricultural hectare) were investigated but only "K_2Oarable" was chosen for analysis because it was not believed that this part of the world has GNP per capita to fertilize the orchards and the meadows. Even for the countries that were available, the data were incomplete. It was found that when significance was investigated using stepwise forward or backward variable choice, a reduced number of "degrees-of-freedom" occurred because some countries were dropped out of the regression for not having data in all the variables. Dropping these countries would result in a medium (0.3 to 0.5) level of R^2. When the data were subjected to multiple regressions with the few variables that showed relationships with the dependant variable, a different, lower value of R^2 would be obtained. This was because the simpler regressions were on data that were complete for all countries. Then the R^2's were lower or zero,

from which it was concluded that the 10 additional, poorer countries did not have any pattern, within the variables that were studied, of choosing how much potash they used per hectare. It would appear that the countries of Africa that do not have the wealth to compute and answer all the questions that are asked by the World Bank do not have a pattern of response within the variables that were searched. The more advanced countries in this group (27 out of 37 countries) responded negatively to "private consumption as a percentage of gross domestic product" and negatively to "agricultural area per capita" with an $R^2 = 0.296$. For all 37 countries in the group, the response to only "private consumption as a percentage of gross domestic product" was significant and that was only $R^2 = 0.10$. "Agricultural area per capita" added very little significance. For 36 of the 37 countries, "population growth rate" (a positive relationship) and "private consumption as a percentage of gross domestic product" (a negative relationship) combined for a $R^2 = 0.16$. It seems clear that in this relatively poor area there will be some separation of the countries with higher GNP per capita from the countries with lower GNP per capita. The countries with higher GNP per capita will move toward more potash consumption, while the countries with lower GNP per capita will vary around some low level of potash consumption in a random fashion. This area consumed about one-half of 1% of the world total potash produced for 1990.

South Asia, East Asia, and Pacific.—This region responds positively to GNP per capita (or gross national product per capita) and negatively to population growth. There is a weaker, negative correlation to "average daily calories per capita." These three variables have an $R^2 = 0.83$, which means that these three variables explain about 90% of the variation between the countries. It would appear that this region will be a growth area for the consumption of potash because the region contains the "Four Tigers" of the Pacific, and other countries will attempt to emulate them as a paradigm of movement to healthy nationhood. The problem for some of the countries will be to contain their population growth. This region of the world consumed about 13% of the total potash production in 1990.

Conclusions

This is a cursory report of the study because there was not enough time to study "Rest of Europe and Mediterranean," and "Middle East and North Africa." The Middle East and North Africa is not an important potash consuming area at this time (0.4%) but will grow at a rate above the world norm. The "Rest of Europe and Mediterranean" are the European countries that are not included in the "developed countries." These are the former centrally planned economies who will probably decrease their consumption for 10 years. For the forecasts in figure 1, data from the International Fertilizer Industry Association (IFA) concerning production and imports for the past 3 years was used where it was available. When IFA data were not available, FAO data were used, and 1986–87 consumption data went into the 1987 column and 1987–88 went into the 1988 column.

From the analysis of most of the countries' macroeconomic data and

FIGURE 1

FORECAST OF WORLD POTASH CONSUMPTION

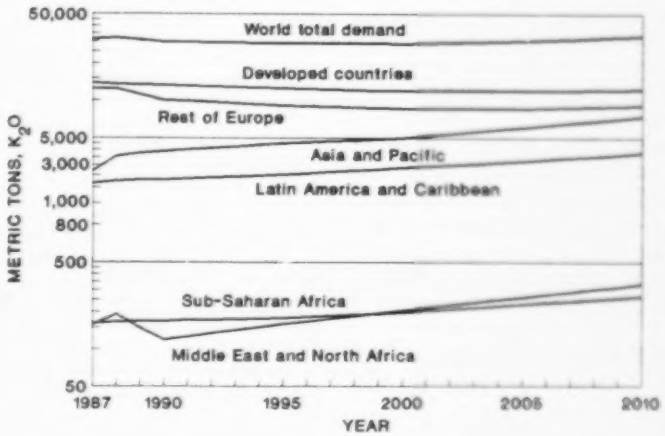
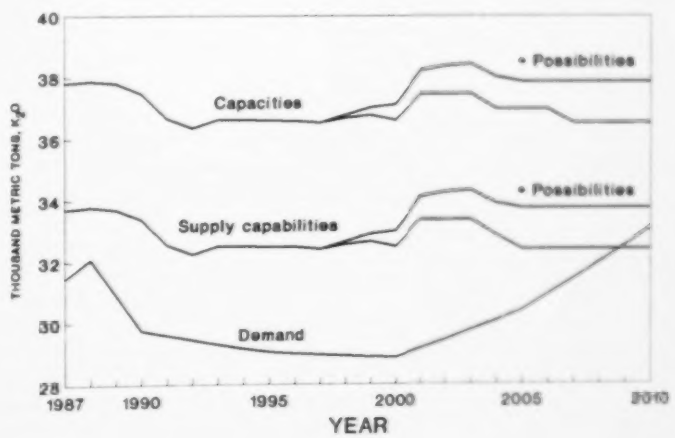


FIGURE 2

FORECAST OF WORLD SUPPLY-DEMAND



potash consumption, and from rudimentary economic analysis, the forecast in figure 2 shows declining or level potash consumption for the world for approximately 10 years. After the year 2000, one might foresee an increase that will be above 1988 levels by the year 2010. Several factors point toward level or declining consumption of potash in the midterm. First, there is the history of declining potash consumption in the United States for several reasons. Second, there is the likelihood of western Europe (European and United Kingdom demand for fertilizers was forecast to fall between 10% to 20% during the 1990's;. . .[6]) slowly dropping its subsidies to the farmers. These factors point to declining potash consumption in the largest consuming group of countries in this study. The former Comecon countries will toil through their conversion to capitalism, or modified capitalism, with much time and money devoted to creating new institutions. The former Comecon countries will consume less potash for 5 to 10 years as they modify their thinking from subsidized potash consumption under central planning to individual farmers computing their marginal investment in potash for the marginal profit.

The possible new capacities that might start production after the year 2000 are in Brazil, Egypt, Israel, and Saudi Arabia. Israel and Saudi Arabia have or can hire the technical expertise to develop underground resources in their countries that are now being investigated. Egypt, if the resource turns out to be minable, will be able to borrow the money to initiate the project, and it will pursue the project with interest. All three locations are close to water for shipping anywhere in the world. The potash resources in Manaus, Brazil, will be near water deep enough for barging to deepwater ports, but are likely to be consumed within Brazil if either of the two resources are economically viable. It is not clear what the U.S.S.R. will do with the new resources that it has identified. This country will be busy with other problems for many years.

[1] All tonnages are reported in metric tons, K_2O equivalent, unless otherwise noted.

[2] Mining Journal (London). AMAX'S Lithium Withdrawal. V. 315, No. 8096, Nov. 9, 1990, p. 353.

[3] ———. Yolanda Debate. V. 315, No. 8102, Dec. 21 28, 1990, p. 472.

[4] Green Markets. China Shifts Attention to Phosphate and Potash Production. Sept. 17, 1990, pp. 5–6.

[5] Golovkov, B. Y. Development of Potash and Salt in the U.S.S.R. to Enter Pacific Rim Markets. Paper in Ninth Industrial Minerals International Congress (Sydney, Australia, 25–28 Mar. 1990) Met. Bull. PLC, Mar. 1990, pp. 159–164.

[6] Fertilizer International. Kemira Picks Up the Pieces. No. 288, Aug. 1990, pp. 30–31.

OTHER SOURCES OF INFORMATION

Bureau of Mines Publications

Potash. Ch. in Mineral Commodity Summaries, annual.

Potash. Reported biannually in Mineral Industry Surveys.

Other Sources

British Sulphur Corp. Ltd., London. Phosphorus & Potassium, bimonthly. Fertilizer International, monthly.

Department of Energy, Mines, and Resources, Ottawa, Canada. Canadian Minerals Yearbook, Ch. on Potash, annual.

Fertecon Ltd., London. World Fertilizer Review, monthly.

FMB Publications Ltd., Middlesex, England. Fertilizer Focus, monthly.

IPC Industrial Press, Inc., European Chemical News, weekly.

McGraw-Hill Inc., Washington, DC. Green Markets, weekly.

Potash & Phosphate Institute, Atlanta, GA. Supply-Demand Statistics, monthly, quarterly, and annually.

United Nations, Food and Agriculture Organization. Annual Fertilizer Review.

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